Experimental Determination of Preswirl Effects on Damping Seal Performance

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The destabilizing forces generated by the seals, turbines, splines, and impellers of a turbopump increase with pump speed. These whirl drivers are opposed by the stabilizing damping forces associated with the seals and bearings of the pump. At high speeds the destabilizing forces exceed the stabilizing forces and the rotor will whirl at frequencies near the lowest critical frequency of the rotor. This self-excited vibration is potentially destructive and imposes limits on turbomachinery performance. For example, a high-pressure oxidizer turbopump was destroyed early in the development program by subsynchronous vibration and a speed limit had to be imposed on the turbopump. The whirl problem was eliminated by adding two shaft pilots and replacing two labyrinth seals with damping seals.

Computer codes developed at MSFC have shown that damping seals inhibit subsynchronous whirl by providing more damping than whirl forces. These codes indicate seal roughness and fluid preswirl have important effects on the seal's stabilizing capacity. The objective of this program is to experimentally assess the effect of roughness and fluid preswirl on damping seal performance. The effect of roughness will be established using an existing test rig to compare the performance of a smooth seal and a seal with an isogrid roughness pattern. Tests will be performed at 5,000-, 10,000-, and 15,000-r/min and 1,000-, 1,500-, and 2,000-lb/in^2 delta pressure. The effect of fluid preswirl will then be established by repeating this test series with a new shaft that will greatly increase the tangential velocity of the fluid. Resulting data will be compared to computer program predictions, and anchored programs will then be used to design new turbomachinery.

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Biographical Sketch: Eric Earhart holds a B.S. degree in mechanical engineering from the University of Wisconsin. He has been with the Marshall Space Flight Center for 7 years and specializes in rotordynamics.